- 2 -

corresponding to the vibrations of the target. However, the speckle fluctuations at each receiver are substantially uncorrelated with the others, so the signal amplitudes from each receiver pass through minima at different times, so combining the demodulated outputs from each receiver with the others

5   produces a composite signal in which temporary loss of vibrational data from the target is minimised or eliminated.

However, in the method and apparatus described, it is not a straightforward matter to define the optimum method for combining the demodulated outputs from the receiver array to maintain a constant vibration

10 signal, and to minimise the overall receiver noise. For example, a simple addition of the demodulated signals does not give the optimum result.

According to the invention there is provided, a laser vibrometer for identifying remote targets by detecting mechanical vibrations therein, said vibrometer having an array of coherent optical receivers, each receiver having

15 an output, said outputs of the receivers being combined by signal processors to produce a signal representative of the remote target, said signal being substantially unaffected by laser speckle.

Optionally, the signal processors may comprise a phase-locked loop having multiple inputs, in which the signal derived from the multiple inputs is

20 representative of the remote target, substantially unaffected by laser speckle. Preferably, the phase-locked loop may comprise multiple signal multipliers, said multipliers multiplying the input signals by a further signal generated by a voltage controlled oscillator. Conveniently, the further signal may comprise a sinusoidal or a square wave. Advantageously, the phase-locked loop may

25 further comprise multiple low pass filters, said filters having cut-off frequencies in the kilohertz region. Preferably, the phase-locked loop further may comprise a summing amplifier which sums the signals generated by the multiple low pass filters and outputs a signal to an integrator and, optionally, the integrator may output a signal to an input of the voltage control oscillator, said voltage control

30 oscillator generating a signal which is input into the inputs of the multiple signal multipliers.

- 3 -

Preferably, the signal processors may comprise an autocovariance processor having multiple inputs, in which the signal derived from the multiple inputs is representative of the remote target, substantially unaffected by laser speckle. Advantageously, the signals output by the multiple receivers may be

5   passed to conversion means, said conversion means sampling the input signals to produce digital outputs in response to timing signals generated by a timing pulse generator. Conveniently, the signals output by the multiple receivers may be further passed to time delay means, said time delay means delaying the input signals by approximately 0.25 of a cycle at the centre frequency of the

10   signals from the receivers. Optionally, the time-delayed signals may be passed to further conversion means, said further conversion means sampling the input signals to produce digital outputs in response to timing signals generated by a timing pulse generator. Preferably, the laser vibrometer may further comprise summation means, for receiving the first and second converted signals, said

15   converted signals comprising signal pairs, and performing a summation on said pairs of signals, said summation causing the signal due to the laser speckle to be greatly reduced and a signal representative of the mechanical vibration of the remote target to be output by the summation means.

According to the invention there is further provided, a method of

20   detecting the mechanical vibrations of a remote target using a laser vibrometer, comprising the steps of:
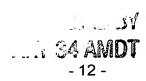
(a)   illuminating the remote target with laser light;

(b)   collecting a portion of the laser light reflected by the remote target using a coherent optical receiver having multiple inputs;

25   (c)   detecting the outputs of the optical receivers;

(d)   processing said multiple outputs; and generating a signal representative of the mechanical vibration of the remote target, said signal being substantially unaffected by laser speckle.

In this way, signals from each receiver are combined, either by means of

30   a phased-locked loop with multiple inputs, for example, or by means of a complex autocovariance processor with multiple inputs, as a further example, to

- 11 -

CLAIMS

1.   A laser vibrometer for identifying remote targets by detecting mechanical vibrations therein, said vibrometer having an array of coherent optical receivers, each receiver having an output, said outputs of the receivers being combined by signal processors to produce a signal representative of the remote target, said signal being substantially unaffected by laser speckle.

2.   A laser vibrometer according to claim 1, in which the signal processors comprise a phase-locked loop having multiple inputs, in which the signal derived from the multiple inputs is representative of the remote target, substantially unaffected by laser speckle.

3.   A laser vibrometer according to claim 2, in which the phase-locked loop comprises multiple signal multipliers, said multipliers multiplying the input signals by a further signal generated by a voltage controlled oscillator.

4.   A laser vibrometer according to claim 3, in which the further signal comprises a sinusoidal or a square wave.

5.   A laser vibrometer according to any one of claims 2 to 4, in which the phase-locked loop further comprises multiple low pass filters, said filters having cut-off frequencies in the kilohertz region.

6.   A laser vibrometer according to any one of claims 2 to 5, in which the phase-locked loop further comprises a summing amplifier which sums the signals generated by the multiple low pass filters and outputs a signal to an integrator.

7.   A laser vibrometer according to claim 6, in which the integrator outputs a signal to an input of the voltage control oscillator, said voltage control oscillator generating a signal which is input into the inputs of the multiple signal multipliers.

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8.   A laser vibrometer according to claim 1, in which the signal processors comprise an autocovariance processor having multiple inputs, in which the signal derived from the multiple inputs is representative of the remote target, substantially unaffected by laser speckle.

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9.   A laser vibrometer according to claim 8, in which the signals output by the multiple receivers are passed to conversion means, said conversion means sampling the input signals to produce digital outputs in response to timing signals generated by a timing pulse generator.

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10.   A laser vibrometer according to claim 9, in which the signals output by the multiple receivers are further passed to time delay means, said time delay means delaying the input signals by approximately 0.25 of a cycle at the centre frequency of the signals from the receivers.

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11.   A laser vibrometer according to claim 10, in which the time-delayed signals are passed to further conversion means, said further conversion means sampling the input signals to produce digital outputs in response to timing signals generated by a timing pulse generator.

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12.   A laser vibrometer according to claim 11, further comprising summation means, for receiving the first and second converted signals, said converted signals comprising signal pairs, and performing a summation on said pairs of signals, said summation causing the signal due to the laser speckle to

be greatly reduced and a signal representative of the mechanical vibration of the remote target to be output by the summation means.

13.   A method of detecting the mechanical vibrations of a remote
5   target using a laser vibrometer, comprising the steps of:

(a)   illuminating the remote target with laser light;

(b)   collecting a portion of the laser light reflected by the remote target using a coherent optical receiver having multiple inputs;

(c)   detecting the outputs of the optical receivers;

10   (d)   processing said multiple outputs; and generating a signal representative of the mechanical vibration of the remote target, said signal being substantially unaffected by laser speckle.

14.   A laser vibrometer as substantially as hereinbefore described with
15   reference to Figure 1 or Figure 2 of the attached diagrammatic drawings.

15.   A method of detecting the mechanical vibrations of a remote target using a laser vibrometer, substantially as hereinbefore described with reference to Figure 1 or Figure 2 of the attached diagrammatic drawings.
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